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**GEOGRAPHY, ENVIRONMENT  
AND POPULATION**



## Location

The Macao Special Administrative Region (MSAR) is an integral part of the People's Republic of China. Situated at the mouth of the Pearl River Delta (PRD) and bordering Guangdong Province, Macao is 60 kilometres from Hong Kong, and located at latitude 22°12'40"N and longitude 113°32'22"E. Macao time is eight hours ahead of Greenwich Mean Time. The MSAR consists of the Macao peninsula and two islands: Taipa and Coloane. Three bridges – Nobre de Carvalho Bridge, Friendship Bridge (Ponte da Amizade) and Sai Van Bridge – link the peninsula to Taipa; while the COTAL Reclamation Area links Taipa and Coloane islands.

According to Chief Executive Notice No.128/2015 dated 20 December 2015: as stipulated in Order No. 665 of the State Council of the People's Republic of China, the Macao Special Administrative Region comprises land and marine areas, with the land area comprising the Border Gate Macao Checkpoint Building section and the Canal dos Patos section, and the marine area comprising six sections: the Inner Harbour section, Cotai channel section, southern Macao waters section, eastern Macao waters section, artificial island section, and northern Macao waters section. The boundary to the west is meridian 113°31'41.4"E, to the east 113°37'48.5"E, to the south parallel 22°04'36"N, and to the north 22°13'01.3"N.

## Area

Due to reclamation along its coastline, Macao's total land area has grown from 11.6 square kilometres in 1912, when measurements were first taken, to 32.9 square kilometres in 2018. The Macao peninsula accounts for 9.3 square kilometres (28.3 percent) of the current area; Taipa island for 7.9 square kilometres (24 percent); Coloane island for 7.6 square kilometres (23.1 percent); COTAL Reclamation Area for six square kilometres (18.2 percent); New Urban Zone Area A for 1.4 square kilometres (4.3 percent); Macao border crossing area on Zhuhai-Macao checkpoint on the Artificial Island of the Hong Kong-Zhuhai-Macao Bridge for 0.7 kilometres (2.1%), and the campus of the University of Macau for one square kilometre.

According to Chief Executive Notice No.128/2015 dated 20 December 2015: as stipulated in Order No. 665 of the State Council of the People's Republic of China, the Central People's Government explicitly determines that the area of waters of the Macao Special Administrative Region is 85 square kilometres.

## Geology and Topography

Macao mainly comprises flat land, terraces and hills. The area of flat land (including reclaimed land) is 23.8 square kilometres, accounting for 72.3 percent of the total; granite hills cover six square kilometres, or 18.2 percent; and terraces cover 1.2 square kilometres, or 3.7 percent. The terraces are historically areas of denudation, extending

along St Augustine, Luis de Camoes Garden, the hill behind Mong Ha Kun lam Tong Temple, Russa Hill, and the southern part of Taipa island. Their relatively small area, low elevation (20-25 metres) and gentle slopes mean that most of the terraces are fully utilised. The remaining land – including reserves, monument sites and forests – occupies approximately 1.9 square kilometres, accounting for 5.8 percent of the total land area.

The elevation of Macao increases from the north to the south. Guia Hill, in the north, is the highest point on the Macao peninsula, with an altitude of 90 metres. To the south, Alto de Coloane is the highest hill on Coloane island, as well as the highest point in Macao, with an altitude of 170.6 metres. Taipa Grande, the main peak of Taipa island, has an altitude of 158.2 metres.

## Coastline Assessment

According to Executive Order No. 184/2018 enacted on 13 August, the coastline of the Macao SAR was determined by the published Macao Special Administrative Region Coastline Map, dated 1 July 2017. The total length of Macao's coastline is 76.7 kilometres, 18.4 kilometres of which are around the Macao peninsula; 49.9 kilometres are around the two islands (including Taipa Island, Cotai Reclamation Area and Coloane Island); 5.7 kilometres are around New Urban Zone Area A; 2.7 kilometres are around the Macao border crossing area on Zhuhai-Macao Port Artificial Island of the Hong Kong-Zhuhai-Macao Bridge.

There are two types of coastline in the Macao SAR: artificial and natural coastlines. Artificial coastlines predominate, representing 81.5 percent of the total coastline length, and are mainly around the Macao peninsula and fringing eastern and northern Taipa Island. The natural coastlines mainly fringe western Taipa Island and a the southern tip of Coloane Island, representing 18.5 percent of the total coastline length.

## Climate

Macao is situated in a subtropical zone, with the Asian continent to the north and a wide tropical sea to the south. In winter, Macao experiences northerly winds, cold and dry weather and low rainfall, due to a cold continental high-pressure system at medium and high latitudes. In summer, Macao is mainly subject to south-westerly winds, hot and wet weather and heavy rainfall, due to the influence of oceanic tropical weather systems. The reverse of wind directions in winter and summer, together with minimal temperature variations during the day, give Macao a marine monsoon climate.

According to the climate normals of the World Meteorological Organization (WMO), calculated with 30 years of data, the average annual precipitation in Macao between 1981 and 2010 was more than 2,000 millimetres, with most rainfall occurring between April and September. June had the most precipitation – an average of 363.8 millimetres; while January had the least – an average of 26.5 millimetres.

Macao has an average annual temperature of 22.6°C. The coolest month is January, when it averages 15.1°C. Most years, Macao has a short cold weather period when temperatures fall below 5°C. The average monthly temperature exceeds 22°C during seven months of the year, indicating that Macao has a short winter but a long summer.

Macao is frequently hit by typhoons. The typhoon season starts in May and ends in October, with July to September as its peak period.

## Weather Overview

### General Situation

In 2018, Macao's average annual temperature and the relative humidity were slightly higher than the climate normal, while the total rainfall and the total evaporation level were significantly lower than the climate normal, and the total hours of sunshine was slightly below the climate normal.

Seven tropical cyclones affected Macao in 2018. They were: Tropical Storm Ewiniar from 5 June to 8 June, Tropical Storm Son-Tinh from 17 July to 18 July, a tropical depression from 23 July to 24 July, Severe Tropical Storm Bebinca from 9 August to 15 August, Tropical Storm Barijat from 11 September to 13 September, Super Typhoon Mangkhut from 15 September to 17 September, and Super Typhoon Yutu from 31 October to 2 November. Super Typhoon Mangkhut brought severe damage to Macao, resulted in Typhoon Signal No. 10 being issued for the first time since Typhoon Hato in 2017.

During Typhoon Mangkhut, the maximum wind speed was 137 kilometres per hour. Typhoon Signal No. 8 was also issued as strong Tropical Storm Bebinca approached, as a precaution given its erratic movement. The warning signal lasted for 138 hours, which set a new record for the most hours a signal has been issued.

Regarding storm surge warnings, a warning was issued as a result of Tropical Storm Son-Tinh; blue storm surge warnings were issued as a result of Strong Tropical Storm Bebinca and Tropical Storm Barijat, and a black storm warning was issued as a result of Super Typhoon Mangkhut.

## Summary of Severe Weather Warnings Issued in 2018

Warning / Signal Type		Frequency	No. of Warning Reports Issued
<b>Tropical Cyclone Warning</b>	No. 1 Alert Signal	7	42
	No. 3 Strong Wind Signal	5	69
	No. 8 Northeast Gale Signal	2	10
	No. 8 Southeast Gale Signal	2	10
	No. 8 Southwest Gale Signal	0	0
	No. 8 Northwest Gale Signal	0	0
	No. 9 Increasing Gale Signal	1	2
	No. 10 Typhoon Signal	1	9
	All Signals Lowered	7	7
<b>Strong Monsoon Warning (Black Ball)</b>		22	84
<b>Rainstorm Warning</b>		8	30
<b>Thunderstorm Warning</b>		79	207
<b>Storm Surge Alert</b>		3	9
<b>Storm Surge Warning</b>	Blue Storm Surge Warning	22	48
	Yellow Storm Surge Warning	0	0
	Orange Storm Surge Warning	0	0
	Red Storm Surge Warning	1	17
	Black Storm Surge Warning	1	9
	All Warnings Lowered	3	3

## Temperatures

Macao had an average annual temperature of 22.8°C during 2018, which was

0.2°C higher than the climate normal. The highest and the lowest average temperatures were 28.1°C in July and 15°C in January and February, respectively. The hottest day was 29 May, when the temperature rose to 35.8°C; whereas the coldest day was 1 February, when the temperature fell to 4.6°C.

## Relative Humidity

The average relative humidity during 2018 was 81 percent, which was two percentage points higher than the climate normal. August saw the highest monthly average relative humidity, at 87 percent; whereas the lowest was 72 percent in February.

## Rainfall

Total rainfall during 2018 was 1,795.6 millimetres, which was 262.5 millimetres or about 13 percent less than climate normal. The highest monthly rainfall was 493.6 millimetres, recorded in June, 129.8 millimetres above normal. The lowest monthly rainfall was 8.2 millimetres, recorded in December. The highest daily rainfall was 108.2 millimetres, recorded on 16 September.

## Evaporation

The total evaporation level in 2018 was 790.9 millimetres, which was 154.2 millimetres less than the climate normal. The evaporation levels in February and May were slightly higher than the climate normal, while the evaporation levels of other months in the year were all lower than the climate normal.

## Sunshine

During 2018, Macao had 1,744.4 hours of sunshine, 29.5 hours less than normal. The most hours of sunshine were recorded in May, totalling 246.4 hours, 110 hours above normal. The least hours of sunshine were recorded in February, amounting to 91.6 hours, which was 12.2 hours more than normal.

## Wind

During 2018, Macao was subject to predominantly north-northeasterly winds in January, February and from September to November; easterly winds in March and July; south-southeasterly winds in April; southerly winds in May, June and August; and northerly winds in December. Wind speeds averaged 11.2 kilometres per hour.

## Weather Services

### Meteorological and Geophysical Bureau

The Meteorological and Geophysical Bureau (SMG) is supervised by the Secretary for Transport and Public Works. It provides weather reports, monitors air quality and radiation, and conducts research into climate, climate change and earthquakes.

Apart from hourly real-time weather information, the SMG issues various types of daily weather forecasts for the public, government departments and private institutions. These include five weather reports and forecasts, two marine and weather forecasts for the Macao coastal area, as well as weather reports on the preceding day, which are broadcast daily for the public. The SMG provided 1,823 weather forecasts and 729 weather forecasts for the Macao coastal area during 2018.

The SMG continued cooperating with the Macau Broadcasting Company's (TDM). Every day, SMG officers explain the day's weather conditions and the forecast for the following day during the Macau Broadcasting Company's morning TV programme. The SMG forecasters also record weather information regularly, or when necessary, and upload it to the Internet for download and use by various media. This information includes a weather review of the day, a two-day weather forecast and air quality report; a weekly weather forecast; special weather information (on typhoons, rainstorms, very hot and cold weather); and a morning-weather recording.

Whenever a tropical cyclone signal is issued, the SMG provides a warning signal forecast for the following one to two days, based on a table with forecast conditions. Citizens can learn about the potential impact of tropical cyclones during particular hours and make necessary preparations as soon as possible. When Typhoon Signal No.3 or above is issued, TDM uses split-screen views to announce the latest tropical cyclone news.

In response to special weather conditions (such as a forecast of a substantial drop in temperature), the SMG sends special weather notifications to registered users, social welfare organisations and schools via WeChat, mobile applications and SMS.

Through the round-the-clock Automatic Air Quality Monitoring Network, the SMG announces real-time concentration of air pollutants and summarises daily air quality on its website every day. In addition, an air quality forecast for the following day is reported to the public.

The SMG Aeronautic Meteorological Center at Macau International Airport provides half-hourly weather observations and special reports to aviation organisations and flight crews.

The aeronautical meteorological documents include meteorological maps for every route, as well as upper wind and temperature charts, aviation weather reports and forecasts, and volcanic ash and tropical cyclone advisory information. All international

flights departing Macao can receive the most update aeronautical meteorological documents of international standards via the Aviation Weather Information System (AWIS). In 2018, a total of 34,481 aeronautical meteorological documents were downloaded from the system, which typically operated at 99.9 percent efficiency.

In recent years, the SMG has introduced the Mobile WebWeather Service, Macao SMG mobile app and the official WeChat account, "Macao SMG". An SMS service and the 1311 Telephone Voice Response Weather Information Enquiry Service provide a wide array of weather information and air quality indices. The SMG also cooperates with relevant departments to display up-to-date tropical cyclone and rainstorm warnings on the electronic monitors in the Border Gate checkpoint building and the Outer Harbour Ferry Terminal, in order to help border-crossing commuters to promptly respond to changes in weather. In addition, the Weather Service Centre was established at the Outer Harbour Ferry Terminal, to provide travellers with the latest weather advice and information.

The SMG also offered the 48-hour Automatic Weather Forecast and Real-time Air Quality Index services, providing the public with temperature, humidity, wind speed and direction, and weather forecasts for the following two days and more timely air quality index on the website.

The SMG further enriched the website content in 2018. Information on sky views and wind were included in the Automatic Weather Forecast. The air quality index calculation and display were also optimised. Daily maximum and minimum temperatures and other monitoring data, presented in time series charts, were added to the real-time weather information, so that citizens could more conveniently learn about the weather.

After Typhoon Hato in 2017, the SMG carried out a series of refinements and promotions to educate citizens about adverse weather conditions.

The SMG amended the administrative orders regarding tropical cyclones and storm surges. Regarding the Executive Order No. 16/2018 about tropical cyclones, Strong Typhoon and Super Typhoon were added to the levels of tropical cyclone, deepening citizens' understanding regarding the potential level of destruction by a typhoon. As to the Executive Order No. 76/2018 regarding storm surges, the SMG added a Storm Surge Warning, to strengthen storm surge alerts to the public. The number of levels of Storm Surge Warning was increased from three to five, expanding the scope of flood warnings during a storm surge. The rankings are blue, yellow, orange, red and black, in order of severity.

The SMG also strived to educate the public about weather and disaster relief, and cooperated with other organisations in organising talks to introduce common adverse weather conditions and corresponding safety measures.

In 2018, the SMG also redesigned the webpage on Weather Forecasts for Holidays. Many images were used to present detailed weather information to the public. The forecasts now provide various information, depending on the holiday. For example, special notice of rain and humidity would be given during the Dragon Boat Festival,

to alert dragon boat race competitors regarding changes in the weather; notifications are given on the time for enjoying the moon and night time weather during the Mid-Autumn Festival, to help citizens enjoy the celebration.

During 2018, the SMG posted the Storm Surge Alert labels onto the Civil Protection CCTV rods in low-lying areas, to more clearly inform citizens regarding the potentially affected areas and the severity of flooding, enabling prompt response measures when storm surge alerts are issued. Labels were also posted in car parks, to alert car owners and drivers about the potential for storm surges.

## Monitoring Network

The SMG collects weather data 24 hours a day via its Automatic Weather Station Network of 15 weather-observation stations in key locations around Macao. Three of these automatically send information every 15 minutes to destinations worldwide, using the international SYNOP code and the Global Telecommunications System (GTS). This forms part of the Pearl River Delta Real-time Automatic Weather Station Network, which was jointly established to exchange meteorological data by the Guangdong Provincial Meteorological Bureau, the Hong Kong Observatory and the Macao SMG.

The SMG also teamed up with the Hong Kong Observatory to establish a substation of the Pearl River Delta Lightning Location Network in Macao. The system operates around the clock, and provides real-time lightning information for the Pearl River Delta. Two lightning systems with real-time monitor interface were also established in 2018.

Regarding meteorological telemetry, the SMG has two ground meteorological reception and processing systems to receive Japanese Himawari-8 satellite information and Chinese FY-2E and FY-2G satellite information, respectively; two dual-polarisation Doppler weather radars; three low-level wind profilers; two microwave radiometers; a cloud height meter; three visibility measuring devices; and two lightning sensors to monitor lightning in the skies over Macao and the vicinity.

The SMG cooperates with related departments to establish the Water Level and Tide Monitoring Network, to provide round-the-clock real time data on flooding and tides in flooding black spots and coastal area. The network includes 17 land water level monitoring stations set up at flooding black spots in various districts of Macao, two tide monitoring stations set up along the coast, and two inshore wave monitoring stations.

In addition, the SMG cooperated with the Pearl River Water Conservancy Science Academe to commence work on marine meteorological observations. By the end of 2018, real-time monitoring data was received from the marine buoy stations in the Macao and Pearl River Water regions set up by the academe, expanding monitoring from land-based meteorology to include nearby sea areas, including hydrology, and providing real-time data as a reference for storm surge monitoring and issuing alerts.

Air quality monitoring: The SMG established the Air Quality Monitoring Project in

partnership with Companhia de Electricidade de Macau (CEM). The SMG employs a fully automated air monitoring network to measure major pollutants that jeopardise Macao's air quality. Macao has six automatic air quality monitoring stations, a light detection and ranging (LIDAR) system for monitoring suspended particulates and boundary layers above Macao and two mobile air monitors to monitor air quality of different districts in Macao. Moreover, in July 2012 the SMG adopted a new air quality standard, raising the air quality standard to WHO interim target-1 (IT-1).

**Seismological monitoring:** The SMG has a seismological monitoring station in its Taipa Grande headquarters on Taipa, equipped with a digital seismograph and a deep shaft (30 metres from ground level) digital seismograph. In 2014, the deep shaft digital seismograph was upgraded and became a monitoring station of the Pearl River Delta Earthquake Early Warning Network. In addition, a seismic information sharing portal was introduced, to receive earthquake information for the entire country.

**Environmental radiation monitoring:** The SMG's headquarters is equipped with an environmental radiation monitoring station, mainly for detecting Gamma radiation dose rates in the atmosphere and announcing the results on the website. A baseline survey on Macao's atmospheric radiation began in 2013. Regular monitoring of Macao's atmospheric radiation is conducted every year in different districts.

## Regional and International Cooperation

The SMG is a member of the WMO. It actively participates in promoting technology, research, training and applications relating to meteorology. Every year, it sends delegations to meetings, seminars, workshops and training programmes arranged by the WMO, mainland China and overseas meteorological agencies and academic organisations.

The SMG is also a member of the ESCAP/WMO Typhoon Committee. The committee secretariat moved to Macao in 2007.

The SMG keenly takes part in meteorological science meetings and exchange activities conducted by its mainland China and overseas counterparts. Every year, it participates in the Guangdong-Hong Kong-Macao Seminar on Meteorological Science and Technology and the Guangdong - Hong Kong - Macao Meeting on Cooperation in Meteorological Operations organised alternately by the three parties, with the 2018 meeting hosted by the SMG; and the Eighth Guangdong - Hong Kong - Macao Seminar on Earthquake Science and Technology, and the Meeting of the Third Assessment Report on the Influence of Climate Change on Tropical Cyclones in the Typhoon Committee Region.

The SMG also attended:

- The 50th Session of the ESCAP/WMO Typhoon Committee;
- The 22nd Meeting of the Meteorology Sub-group of the Asia Pacific Air Navigation Planning and Implementation Regional Group;

- The 16th Session of Commission for Aeronautical Meteorology of World Meteorological Organization;
- The Second China-ASEAN Meteorological Forum;
- The 13th ICAO Air Navigation Conference;
- The 17th WMO/CIMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation;
- The 13th Typhoon Committee Integrated Workshop;
- The 24th Conference of the Parties to the United Nations Framework Convention on Climate Change;
- The 14th Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol and the third Session of the 1st Conference of the Parties serving as the meeting of the Parties to the Paris Agreement;
- The Academic Advisory Committee of the Regional Key Laboratory for Numerical Weather Prediction (NWP) of Guangdong Province;
- The South China Sea Fengyun Forum;
- The Guangdong-Hong Kong-Macao Greater Bay Area Seminar on Meteorological Development Planning;
- Meeting on Hong Kong-Zhuhai-Macao Bridge Meteorological Services;
- Workshop on Typhoon Defence and Forecast Techniques in Pearl River Delta Cities;
- The Guangdong-Hong Kong-Macao Joint Regional PM<sub>2.5</sub> Study;
- The National Meteorological Departments Director Conference;
- 2018 Typhoon Committee Roving Seminar; and
- The Guangdong-Hong Kong-Macao Air Quality Monitoring and Forecasting Techniques Seminar.

## Air

Population density, scarcity of land, narrow streets and busy traffic all affect Macao's air quality. However, this is offset to some extent by the low discharge of industrial pollutants. The air quality is therefore generally quite good. Every winter, a comparatively high level of airborne pollutants raises the air pollution index; while in summer the air quality improves, with lower pollution index readings, as the convective precipitation of the tropical climate dispels pollutants.

During 2018, roadside monitoring stations in Macao recorded "good" air quality on 66 percent of days, "acceptable" air quality on 33.1 percent of days, and "poor" air quality on 0.8 percent (three days). In the high-density residential area of the Macao peninsula, the air quality was "good" on 64.7 percent of days, "acceptable" on 33.9

percent of days, and “poor” on 1.4 percent (five days).

In the high-density residential area on Taipa, the air quality was “good” on 61.91 percent of days, and “acceptable” on 38.9 percent of days. Ambient monitoring stations on Taipa recorded “good” air quality on 52.1 percent of days, “acceptable” air quality on 40 percent of days, and “poor” air quality on 7.9 percent of days (29 days). Ambient monitoring stations on Coloane recorded “good” air quality on 53.6 percent of days, “acceptable” air quality on 42.5 percent of days, and “poor” air quality on 3.9 percent of days (14 days). The Ka Ho roadside monitoring station recorded “good” air quality on 52.2 percent of days, “acceptable” air quality on 44.4 percent of days, and “poor” air quality on 3.3 percent of days (12 days).

In 2018, fine suspended particulates (PM<sub>2.5</sub>) and ozone (O<sub>3</sub>) were the main pollutants that led to “poor” air quality in Macao, with the former primarily affecting Macao in winter while the latter mainly affected Macao in summer and autumn. The ambient monitoring stations on Taipa recorded most of the “poor” and “bad” air quality, on 7.9 percent of days (29 days). Overall, over 92.1 percent of days met the air quality standards (“good” to “acceptable”) in 2018. As compared to 2017, concentrations of respirable suspended particulates and ozone showed a slightly increase, while concentrations of other pollutants were largely unchanged.

Average Pollutant Concentrations in 2018						
Monitoring Station	Respirable suspended particulates (µg/m <sup>3</sup> )	Fine suspended particulates* (µg/m <sup>3</sup> )	Sulphur dioxide (µg/m <sup>3</sup> )	Nitrogen dioxide (µg/m <sup>3</sup> )	Ozone (µg/m <sup>3</sup> )	Carbon monoxide (mg/m <sup>3</sup> )
Roadside	50.4	25.8	---	52.6	---	0.9
High-density residential area of Macao peninsula	48.9	22.7	5.3	47.9	32.3	0.7
High-density residential area of Taipa island	38.1	18.6	4.0	27.6	59.8	0.6
Taipa ambient	41.2	24.2	7.2	39.5	59.1	0.6
Coloane ambient (i)	42.4	30.3 <sup>b</sup>	0.8	26.3	60.0	0.6
Ka Ho roadside <sup>a</sup>	38.1	18.6	4.0	27.6	59.8	0.6

- a. The monitoring station in a high-density residential area of Taipa island resumed service on 8 August 2018.
- b. The PM<sub>2.5</sub> monitoring station of Ka Ho roadside was suspended from 4 May to September 24 2018, due to a technical failure and construction.

## Comparisons between Pollutant Concentrations and the Daily Air Pollution Index

Air quality Index	Respirable suspended particulates 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Fine suspended particulates 24-hour Average ( $\mu\text{g}/\text{m}^3$ )	Sulphur dioxide 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Nitrogen dioxide 1-hour average ( $\mu\text{g}/\text{m}^3$ )	Ozone 8-hour average ( $\mu\text{g}/\text{m}^3$ )	Carbon monoxide 8-hour average ( $\text{mg}/\text{m}^3$ )
0	0	0	0	0	0	0
50	100	35	40	100	80	5
100	150	75	125	200	160	10
200	350	150	660	750	350	17
300	420	250	1,300	1,500	600	34
400	500	350	1,700	2,000	800	46
500	600	500	2,120	2,500	1,000	57

## Air Pollution Index

Air quality Index	0~50	51~100	101~200	201~300	301~400	401~500
Air quality level	Good	Acceptable	Poor	Bad	Severe	Harmful
Symbol						

## Noise

There are many reasons for noise pollution in Macao. Urban characteristics – such as population density, busy traffic, narrow streets and the large number of high-rise buildings – create conditions for noise transmission.

In 2018, the Environmental Protection Bureau and the Public Security Police received 8,873 complaints about ambient noise, about 0.05 percent more than the 2017 figure. The Environmental Protection Bureau received 1,367 of these complaints, representing an increase of 4.83 percent compared with 2017; whereas the Public Security Police received the remaining 7,506 cases, a figure that was 0.78 percent less than in 2017.

Complaints received by the Environmental Protection Bureau and the Public Security Police were primarily related to “Activities of daily life and pets in residential buildings” (31.1 percent or 2,757 cases), public areas (34.7 percent or 3,077 cases), and industry, commerce and services (14.7 percent or 1,304 cases).

## Environmental Noise Monitoring Network

Currently, Macao has six environmental noise monitoring stations – three on the Macao peninsula, one on Taipa island, one in the COTAI Reclamation Area and one in Coloane. These monitoring stations conduct round-the-clock monitoring of ambient noise; road traffic noise; and noise from the residential zones, by means of an automated network. Data on such noise readings are published monthly in the Environmental Geographic Information System on the Environmental Protection Bureau’s website. The 2017 Annual Report of the Data Collected by Environmental Noise Monitoring Stations of Macao and the 2017 Environmental Noise Census were also published in 2018.

## Water Quality and Wastewater Treatment

### Water Quality

Situated at the mouth of the Pearl River, Macao occupies a peninsula and nearby islands facing Lingdingyang to the east and the South China Sea to the south; there is a wide expanse of water. Water exchanges resulting from tidal flows dilute pollutants entering the area. The Inner Harbour to the west of Macao is a favourite berthing place for Zhuhai and Macao fishing boats. The sluice of the Zhuhai Qianshan River lies upstream of the Inner Harbour channel, and when this is closed the area is partially blocked off. The poor exchange of its waters with the sea results in conditions in which pollutants can accumulate. When the sluice is open, Macao’s water quality is determined by the quality of the water in the Qianshan River. Pollutants that have accumulated will then flow to neighbouring waters.

Based on the geographic features of Macao, the Public Health Laboratory of the Health Bureau adopts Category 3 Water Quality Standard of the Sea Water Quality Standard of China (GB3097-97), to assess individual indicators, nutrition indicators and comprehensive indicators of the water quality at each monitoring station.

### Water Quality Monitoring Network

Three automatic water quality monitoring stations are under the management of

the Environmental Protection Bureau at Ilha Verde Dockyard, Inner Harbour and Cotai Nature Reserves. Round-the-clock monitoring of water quality is conducted through an automated network. Data on the water quality readings are published monthly in the Environmental Geographic Information System on the Environmental Protection Bureau's website. The 2017 Annual Report on the Data Collected by Automatic Water Quality Monitoring Stations of Macao was also published in 2018. The bureau also continued monitoring coastal water quality in 2018.

## Monitoring Drinking Water Quality

The Civic and Municipal Affairs Bureau Laboratory is responsible for the public water supply network; inspecting the water quality of public water sources and wells; and – if necessary – recommending the closure of these facilities in the public interest. It regularly monitors the quality of water processed by the water supply company, and other water supply networks and reservoirs in the territory, to verify whether the quality complies with the requirements stipulated in the Rules and Regulations on Water Supply and Drainage in Macao (Decree-Law No. 46/96/M).

Since being awarded the ISO/IEC 17025 Certificate of Laboratory Accreditation by the China National Accreditation Committee for Laboratories (CNAL; now China National Accreditation Service for Conformity Assessment) in 2003, the laboratory has enhanced its analytical performance and its quality management system. The laboratory also continued to participate in proficiency tests held by renowned organisations in mainland China and countries including the United States, the United Kingdom and Australia. The laboratory's inspection technology has fulfilled international requirements. Currently, it possesses 91 and 205 accreditations on water quality certificates and various food certificates, respectively.

## Wastewater Management

The five sewage treatment facilities in Macao – the Macao Peninsula Sewage Treatment Plant, Taipa Sewage Treatment Plant, Coloane Sewage Treatment Plant, Macau International Airport Sewage Treatment Plant, and Crossborder Industrial Zone Sewage Treatment Plant – can handle 356,000 cubic metres of sewage per day.

In 2018, the Macao Peninsula Sewage Treatment Plant handled 54,095,990 cubic metres of sewage; Taipa Sewage Treatment Plant handled 9,069,467 cubic metres; Coloane Sewage Treatment Plant handled 17,807,153 cubic metres; the sewage treatment plant at Macau International Airport processed 31,489 cubic metres; and the Crossborder Industrial Zone Sewage Treatment Plant handled 668,885 cubic metres.

The open tenders for optimisation, operation and maintenance of sewage treatment plants in Macao Peninsula commenced in 2018. The optimisation work commenced. Meanwhile, the construction of pretreatment facilities at the Cross-border Industrial

Zone Sewage Treatment Plant for handling waste water from Ilha Verde Water Supply Treatment Plant was completed in 2018, further improving the marine environment in Canal dos Patos. The Macao Sewage Treatment Facilities Master Plan was completed in 2018, after which work began on the preliminary design of Coloane Sewage Treatment Plant Upgrade.

To align with the planning and development of Macao's New Urban Area, the preliminary design and environmental impact assessment of the sewage treatment plant construction in Zhuhai-Macao Port Artificial Island of Hong Kong-Zhuhai-Macao Bridge were completed in 2018. Afterwards, a geological survey was conducted in preparation for constructing and installing the sewage treatment plant and pipes, and tender documents were drafted. The remaining tender procedure would commence upon the completion of various preliminary works.

## Waste Management

Companhia de Sistemas de Resíduos, Lda. (CSR) has been contracted to undertake Macao's household waste collection and conveyance, urban cleaning operations and the cleaning and maintenance of public waste containers, under the Government's supervision. According to statistics provided by the Civic and Municipal Affairs Bureau in 2018, the CSR collected about 300,000 tonnes of household waste in Macao during 2018, an average of about 822 tonnes a day.

Work continued on introducing the policy of "waste reduction at source, sorting and recycling" according to the Macao Solid Waste Resources Management Programme (2017-2026), which was introduced in 2017. The Recycling Industry Equipment and Vehicles Subsidy Scheme was introduced in 2018, to help the recycling industry purchase about 20 items of equipment for dismantling, sorting, compressing, transporting and weighing waste, and light vehicles, in order to improve techniques and foster development of the industry. The draft law on Macao Construction Waste Management System was submitted to the legislature by the end of 2018.

## Waste Classification

The Civic and Municipal Affairs Bureau continued to optimise public sorting and recycling facilities in the community. The number of public collection points in Macao was increased to 356. The bureau also invited schools, government departments, associations, private organisations and buildings to participate in the reusable waste sorting and recycling programme, aiming to provide the public with convenient ways to recycle waste. During 2018, 2,503.1 tonnes of waste paper, 240.5 tonnes of metals and 190.4 tonnes of plastic were recycled through various reusable waste sorting and recycling programmes.

The Civic and Municipal Affairs Bureau continued its glass bottle recycling programme. Participants include hotels, schools, and shopping malls. Public collection points for glass bottles have been set up throughout Macao. A total of 417.5 tonnes of waste glass were recycled during 2018. To reduce the volume of organic waste, a wet market food waste recycling programme, a school food waste recycling programme and a community food waste recycling (pilot) programme were launched; they processed a total of 15 tonnes of food waste during the year. Also, a programme for reusing clothes was jointly launched with the Macau Salvation Army, to improve the system for reusing clothes in Macao; about 635.9 tonnes of used clothes were collected during the year.

The Environment Protection Bureau again organised the “Recycling Red Packets is Very Easy” event during Chinese New Year, attracting widespread participation. Over 600 collection points were set up, and about 2.1 million red packets were collected (about 6,200 kilograms). After sorting, about 1.05 million red packets could be reused (over 3,100 kilograms).

The Environment Protection Bureau organised the first “Recycling Mooncake Boxes is Very Easy” event, and cooperated with government departments, communities, hotels, banks, tertiary institutions and estates to set up over 800 mooncake box collection points, encouraging citizens to follow the principle of “Reuse before recycle”, and reuse clean mooncake boxes before recycling. During the event, a total of 7,000 kilograms of used mooncake boxes was recycled for reuse.

## Macao Waste Incineration Centre

Macao Incineration Centre is responsible for processing all Macao’s solid waste, together with some solid waste collected from the sea by the Marine and Water Bureau. It comprises two plants, with a total processing capacity of 1,728 tonnes of waste per day. During 2018, the centre collected 538,944 tonnes of municipal solid waste, an average of 1,477 tonnes a day.

The waste heat produced by the round-the-clock incineration centre during the treatment of the municipal solid waste can be recovered and used for power generation. The power generated by the centre can supply up to 21MW per hour of electricity at full load to the public grid – sufficient to meet the needs of over 33,000 households in Macao. During 2018, the incineration centre supplied 17,889 units (16,570 kWh) of electricity to the public grid.

During 2018, the preliminary work on the third-phase expansion of the incineration centre continued. The design and environmental impact assessment were completed. The open tender process was carried out in phases.

The Environmental Protection Bureau strived to promote food waste recycling. During 2018, the Restaurants Food Waste Recycling Pilot Project commenced, to further expand the food waste recycling network, handling more food waste from small to medium-size restaurants. The project was also promoted in Macao Food Festival.

## Special and Hazardous Waste Treatment

The Macao Special and Hazardous Waste Treatment Centre, adjacent to the Taipa Incineration Centre, commenced operation in 2007. It handles special waste according to the latest European Union incineration standards, including medical waste, slaughterhouse waste, discarded tyres, carcasses of animals such as horses and dogs, oil residue, and other solid and liquid special wastes.

In 2018, the waste treatment centre's total treatment capacity (including medical waste) was 3,510 tonnes, with discarded tyres comprising 43 percent of the treatment capacity.

Since the Environmental Protection Bureau introduced the Used Battery Collection Scheme, over 1,100 collection points have been set up in schools, merchants, shops, residential and commercial zones, public departments and public refuse tips in various districts of Macao. Over 17,000 used batteries were collected, over 14,500 of which were pretreated primary batteries and exported to Japan via Hong Kong in December 2018, for reuse and recycling treatment, following procedures according to the Basel Convention.

The Computer and Communication Products Recycling Programme donated used newer models of computers, which met the bureau's donation requirements and had received some maintenance, to charities. The remaining computers were collected by the programme contractors for dismantling. The reusable components and materials would be transferred to other regions for recycling treatment, accounting for a total recycling rate of 90 percent. The progress was implemented according to the Basel Convention cross-border transfer procedures.

## Treatment of Construction Waste

The construction waste landfill is located on Avenida do Aeroporto in Taipa. Since it commenced operations in March 2006, it has been mainly used for the disposal of non-combustible inert solid waste produced through excavation, demolition, and construction. The solid waste includes debris, cement blocks, soft soil and marine clay. In 2018, about 2.10 million cubic metres of construction waste were disposed of in the landfill.

## Automatic Solid Waste Collection System

The pilot scheme for automatic solid waste collection in the Areia Preta New Reclamation Zone (NATAP) was established in 2006. The system comprises a number of inlet valves connecting with a network of underground tubes. The solid waste is transported by means of air suction to a collection station between Ponte da Amizade Avenue and Macao Wastewater Treatment Plant, from where it is taken by trucks to the incineration centre. During 2018, open tenders were conducted for the hydrogen

sulphide monitoring, and maintenance of the automatic solid waste collection.

## Legislation and Pollution Control

Legislation enacted in 2018 covering environmental issues includes:

1. By-law No. 32/2018 Recycling Industry Equipment and Vehicles Subsidy Scheme enacted;
2. Amendment to Schedule of By-law No.30/2016 Tailpipe Emission Limits and Measurement of Exhaust Pollutants by Vehicles in-use (Executive Order No. 130/2018);
3. Amendment to Environmental Emission Standards for New Light Vehicles (Executive Order No. 256/2018);
4. Approval of the Table of Parameters of Emissions of Exhaust Pollutants for Vehicles with Four-stroke Engines, to Supersede amendment to Schedule 1 and 2 of Annex 1 of Executive Order No.1/2008 approved by Executive Order No. 356/2010 (Executive Order No. 257/2018);
5. Approval of the Tailpipe Emissions Standard and On Board Diagnostics Specification, to Supersede Schedule 1 and 2 of By-law No. 1/2012 (Executive Order 258/2018);
6. Air Pollutant Emission Standards for Sewage Treatment Plants (By-law No. 37/2018); and
7. Air Pollutant Emission Standards for Pharmaceutical, Copper Clad Laminate Manufacturing and Plastic Processing Factories (By-law No.37/2018).

## International Treaties

**Several international agreements and treaties to address global environmental problems have been made applicable to Macao, including:**

1	<p>Vienna Convention for the Protection of the Ozone Layer</p> <p>Montreal Protocol on Substances that Deplete the Ozone Layer</p> <p>Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer</p> <p>London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer</p>
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<b>Several international agreements and treaties to address global environmental problems have been made applicable to Macao, including:</b>	
1	Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer
2	United Nations Framework Convention on Climate Change Kyoto Protocol to the United Nations Framework Convention on Climate Change
3	Paris Agreement
4	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (with amendments made in 1995, 1998, 2002, 2004 and 2013)
5	Stockholm Convention on Persistent Organic Pollutants (POPs) (with amendments made in 2009, 2011 and 2013)
6	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Appendix III amendment to the Rotterdam Convention adopted in the 8th Conference of the Contracting Parties from 24 April to 5 May 2017
7	The Minamata Convention on Mercury
8	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques
9	Plant Protection Agreement for the Asia and Pacific Region (with amendments made in 1967, 1979 and 1983)
10	International Plant Protection Convention
11	Convention on Biological Diversity
12	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
13	Protocol on Environmental Protection to the Antarctic Treaty

<b>International treaties on maritime safety related to marine environment protection applicable to Macao include:</b>	
1	International Convention on Oil Pollution Preparedness, Response and Co-operation 1990
2	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL)
3	Amendment to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1980
4	International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001
5	Convention on the Conservation of Antarctic Marine Living Resources

### **Environmental Protection Bureau**

The Environmental Protection Bureau (DSPA) is charged with studying, planning, executing, coordinating and promoting environment policies.

### **Advisory Council on the Environment**

The Advisory Council on the Environment is chaired by the Director of Environmental Protection Bureau. Members include a maximum of seven representatives of other entities or government departments, and a maximum of 20 other prominent social figures in the environmental protection field.

The major responsibility of the Advisory Council on the Environment is consulting opinions from different social sectors regarding Macao's environmental protection, and providing recommendations on the study, formulation, implementation, coordination and promotion of environmental policies.

### **Environmental Protection and Energy Conservation Fund**

The Government established the Environmental Protection and Energy Conservation Fund through By-law No. 21/2011, and established the Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme through By-law No. 22/2011, to subsidise enterprises and community groups in Macao to increase their capability for protecting the environment; and to introduce environmental protection techniques and devices for further facilitating the development of environmental protection and its industry.

The Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme was the first subsidy scheme since the establishment of the Environmental Protection and Energy Conservation Fund. It targets commercial enterprises and community organisations. According to Order No. 63/2014 of the Secretary for Transport and Public Works, the application deadline for the Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme was extended to 31 December 2015, receiving over 7,600 applications for subsidies. As at the end of 2018, over 99.8 percentage of applications were handled, of which over 5,000 were approved, involving subsidies of more than 410 million patacas.

The Government established a scheme to subsidise equipment and vehicles for the recycling industry, according to By-law No. 32/2018 Promulgated in November 2018. The application period is from 26 November 2018 to 25 November 2019.

### Promotion of Environmental Protection Education

With the theme “Building a Low Carbon Macao and Embracing a Green Life”, the Environmental Protection Bureau organised 286 events in 2018, with a total of 263,263 participants.

The Macao Green Hotel Award has been held for 11 years, with a marked increase in green hotels from 8 in the first year to 51 in 2018. Green hotels actively adopt environmental-friendly management. The average waste produced per room decreased by more than 30 percent; the total weight of recycled waste is more than 200,000 tonnes; and more than 3,400 tonnes of food waste has been recycled. Significant improvements were also seen in water and energy saving, as well as training for environment protection.

To encourage residents to reduce plastic bag use, the Environment Protection Bureau has jointly organised “Use Fewer Plastic Bags” with various departments, communities and organisations for six consecutive years. More than 300 stores participated in 2018. Over six years, more than 260,000 people participated in this campaign, which saved 260,000 plastic bags.

The Green School Award Project 2018 had the theme “Waste Reduction in Campus”, and gave 25 green school awards, with 17 schools receiving the Green School Honour Award; and 8 receiving the Outstanding Green School Award. In all, 24 teams of teachers and tertiary institution students received the Environment Education Pedagogical Project Award, while 38 schools received Green Campus Fun Awards.

The Environment Protection Bureau launched “Reducing Plastic is Very Easy” with communities, delivery platforms, local restaurants and beverage companies, to encourage citizens not to use disposable utensils when buying take-away food.

To promote “reduce waste at source” and encourage citizens to bring their own water bottles, the Environment Protection Bureau initiated the installation of 13 machines

supplying drinks without cans or bottles [[drinking water dispensers; wonder if anything other than water provide, I rather doubt]] in government departments; introduced three user guides regarding drinking water dispensers, and encouraged people to bring their own water bottles to large public events. This was the first year for drinking water dispensers to be installed for a food festival.

The Environmental Protection Bureau continued implementing the Environmental Protection Fun Bonus Point Scheme. By the end of December 2018, there were more than 9,200 members in the first phase of Environmental Protection Fun – waste reduction and recycling. The second phase of the scheme – moving towards being environmentally-friendly – encouraged people from all walks of life to join the scheme’s frontline team (Environmental Protection Fans). They assisted with providing a guided tour service in Cotai Nature Reserve, to leverage the synergy between teaching and learning.

In addition, they promoted environmental messages to the public during environmental festivals such as Wetland Day, Earth Day and World Environment Day, and traditional festivals such as Lunar New Year, the Mid-Autumn Festival and Christmas, and encouraged the public to participate in environmental activities and put environmental protection into practice.

## Regional Cooperation on Environmental Protection

The 2018 Macao International Environmental Co-operation Forum (2018 MIECF) was held from 12 April to 14 April. The theme was “Innovative Green Development for a Sustainable Future”.

MIECF has comprehensive functions as a global environmental platform to enhance exchanges and cooperation between green enterprises in countries along the “Belt and Road”, and within the Pan-Pearl River Delta Region, the Guangdong-Hong Kong-Macao Greater Bay Area, and Portuguese-speaking and European countries, bringing together high-level representatives from government, industry and the academic sector. Regarding green forums, six green forums and one special event were held in 2018, inviting more than 50 pioneers, multinational enterprises’ senior executives and government officials as guest speakers.

Regarding environmental cooperation in the Pan-Pearl River Delta Region, the Environment Protection Bureau attended the 14th Coordinator Working Meeting of the Joint Conference on Pan-Pearl River Delta Regional Environmental Protection Cooperation, and the 14th meeting of the Joint Conference on Pan-Pearl River Delta Regional Environmental Protection Cooperation.

In June 2018, Guangdong, Hong Kong and Macao jointly announced the 2017 Report of the Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network. The parties will continue to manage and maintain the regional air quality monitoring network.

Under the Framework Agreement on Cooperation Between Guangdong and Macao in Environmental Protection, the cross-border transfer of scrap motorcycles was trialled in 2018. In September, the two sides held the Guangdong-Macao Environmental Protection Cooperation Task Force Meeting, to enhance cooperation in air quality monitoring, marine environmental protection, dredging Canal dos Patos in tandem, scrap vehicle treatment, environmental protection industry exchanges and environmental publicity and education, striving to build a better living environment.

Regarding Hong Kong-Macao environmental cooperation, the two sides attended the 10th Meeting on Environmental Protection Cooperation between Hong Kong and Macao. Representatives discussed the plans for cooperation and exchanged experience and views on several environmental issues, with the aim of jointly together regional environment quality. The Environment Protection Bureau also organised a delegation of 22 members to attend the 13th Eco Expo Asia in Hong Kong.

Under the framework of the Zhuhai-Macao Environmental Protection Cooperation Agreement, the Zhuhai-Macao Environmental Cooperation Working Group Meeting 2018 was held in May 2018. The two sides cooperated and exchanged views on several environmental issues.

### Environmental Protection Planning in Macao

In 2018, the Environmental Protection Bureau continued implementing the long-term tasks in the Environmental Protection Plan of Macao (2010-2020), and commenced a study on the Environmental Protection Plan of Macao (2021-2025).

### Examination of Environmental Data

Complaints received by the Environmental Protection Bureau in 2018:

Category	Number of cases
Noise	1,249
Air pollution	394
Noise and air	90
Noise and other	29
Air and other	26
Environmental hygiene	55
Other	105
<b>Total</b>	<b>1,948</b>

Technical advice provided at the request of other departments in 2018:

Department	Premises and projects	Nos.
Tourist Office	Premises including karaoke bars, bars, hotels, restaurants, sauna and massage establishments, dance halls and health clubs.	296
	Inspections before issuance or renewal of licences	121
Economic Services Bureau	Technical advice	8
	Inspection of industrial sites	6
	Technical advice on applications for import of HCFCs defined as controlled substances under Decree-Law No. 62/95/M	107
Lands, Public Works and Transport Bureau	Projects including piling foundations, environmental protection projects and applications for extension of construction time, construction plans, expansion plans, modification of / legalisation on construction projects	189
Civic and Municipal Affairs Bureau	Technical advice on licensed premises	296
	Site inspections	160

Moreover, the Environment Protection Bureau received 18 environmental impact assessment reports on new projects and related information in 2018.

## Flora

Macao abounds in plant species. More than 1,500 species of vascular plants have been identified in Macao. These are mainly found in woodlands, parks and leisure grounds. Most of Macao's vegetation belongs to the evergreen broad-leaf woodland, tree, shrub and coastal bush groups, including such species as Rose Myrtle (*Rhodomyrtus tomentosa*), Blood-red Melastoma (*Melastoma sanguineum*), Oblong leaved Litsea (*Litsea rotundifolia* var. *oblongifolia*), Pop-gun Seed (*Bridelia tomentosa*), Hong Kong Hawthorn (*Rhaphiolepis indica*) and Linear Forked Fern (*Dicranopteris pedata*). The most common species of cultivated plants are the Chinese Hibiscus (*Hibiscus rosa-sinensis*), Hong Kong Orchid Tree (*Bauhinia blakeana*), Sunshine Tree (*Cassia surattensis*) and False Groundnut (*Desmodium heterocarpon*). Also, according to research conducted until 2010 by the Civic and Municipal Affairs Bureau and researchers from the Shenzhen Fairy Lake Botanical Garden, Macao has 104 species of bryophytes which belong to 34 genera and 63 families. Rare species include *Fissidens macaoensis*, *Kurzia sinensis*, *Phaeoceroa laevis*, *Notothylas japonica* horik, *Micromitrium* and *Vesicularia*. *Fissidens*

*macaoensis* is a new species to science which was officially announced in 2011. As it was discovered in Macao, its Latin name includes “Macao”.

The terrestrial vegetation in Macao has a relatively diverse plant community. Types of vegetation can be identified: coniferous forests, mixed conifer–broadleaf forests, evergreen broadleaf forests. Forest areas on Taipa and Coloane have undergone a compositional transformation. A firebreak was set up, and many indigenous tree species were introduced, including Melia-leaved Evodia (*Tetradium glabrifolium*), Hong Kong Gordonia (*Gordonia axillaris*), Acronychia (*Acronychia pedunculata*), Morris’s Persimmon (*Diospyros morrisiana*), India Carallia (*Carallia brachiata*), Yanmin (*Dracontomelon duperreanum*), Persimmon-leaved Litsea (*Litsea monopetala*), *Michelia chapensis*, Burmese Rosewood (*Pterocarpus indicus*), Heterophyllous Winged-seed Tree (*Pterospermum heterophyllum*), Silver-back Artocarpus (*Artocarpus hypargyreus*), *Pinus elliottii* × *Pinus oaribaea*, Common Fig (*Ficus carica*), Horse-tail Pine (*Casuarina equisetifolia*), Chinese Holly (*Ilex rotunda*), *Michelia macclurei* and Chinese Guger Tree (*Schima superba*).

In addition to leafy plants that were commonly used in the past – namely the Dwarf Yellow (*Duranta repens*), Golden Leaves (*Ficus microcarpa*), Golden Dewdrops (*Duranta repens* ‘*variegata*’), Purple Knight (*Alternanthera dentata*), *Fagraea ceilanica* and Painted Copper Leaf (*Acalypha wilkesiana*) – colours were added to the green belts to improve greening of streets in Macao and create a better view by growing colourful flowering shrubs, such as Indian Azalea (*Rhododendron simsii*), *Cordyline fruticosa*, Small Allamanda, *Lantana montevidensis* and *Ruellia brittoniana* in recent years. The view looks more layered with the addition of these flowers, accompanied by other trees such as Golden Trumpet Trees, *Terminalia mantaly*, Camel’s Foot Tree (*Bauhinia variegata*) and Chinese Banyan (*Ficus microcarpa*).

## Green Week

Green Week in Macao is an annual event organised by the Civic and Municipal Affairs Bureau with the assistance from various organisations in the community. The 37th Green Week in Macao was held from 17 March to 25 March 2018, with the theme “Love the Green City, Plant an Ideal Home”. The event featured over 30 activities, and was attended by some 30,000 participants.

During the event, 1,225 seedlings were planted on land, thousands pots of plants were given away, and a series of educational activities were held to encourage public participation in greening Macao.

## Fauna

Macao is small. The development of land and expansion of urbanisation affect and damage the survival and scope of activities of wild animals. The numbers of species and populations of wild animals in Macao are decreasing.

The scarcity of unpolluted waters in Macao leads to a decrease in the diversity and numbers of amphibians. The five commonest species are Asian Common Toad (*Bufo melanostictus*), Gunther's Frog (*Rana guentheri*), Brown Tree Frog (*Rhacophorus megacephalus*), Paddy Frog (*Fejervarya limnocharis*) and Asian Painted Frog (*Kaloula pulchra*). In the hilly forest area of Coloane, the Civic and Municipal Affairs Bureau has constructed artificial freshwater wetlands as better habitats for amphibians.

The commonest wild mammals are bats, rats and Red-bellied Tree Squirrels. Bats mainly inhabit Coloane and Taipa. In 2013, Chinese Rufous Horseshoe Bat (*Rhinolophus sinicus*) was newly recorded. The Japanese House Bat (*Pipistrellus abramus*) and Short-nosed Indian Fruit Bat (*Cynopterus sphinx*) can be found on the Macao peninsula. The former frequents gaps between buildings and lives on mosquitoes and flies, helping to limit populations of harmful insects. The latter eat fruits in parks or woods, and may help spread their seeds, contributing to the city environment and natural environment of the woods. The Red-bellied Tree Squirrel is an exotic species, formerly imported as a pet. It is now wild in Macao. Its lack of natural enemies poses a threat to other animal species, especially birds, as the squirrels eat their eggs.

Reptiles, especially snakes, play an important ecological role in controlling the number of rats. Large-spotted Cat Snake (*Boiga multimaculata*) and Many-banded krait (*Bungarus multicinctus*), which are relatively rare, were recorded in Coloane in 2013. However, Macao's dense population poses an enormous threat to their dwelling and foraging areas. In addition, some people's misunderstanding and fear about snakebites have caused the number of snakes to decrease most significantly among all wild animals in Macao.

Previous studies recorded over 300 species of birds in Macao. Dominant species were Chinese bulbul (*Pycnonotus sinensis*, terrestrial) and Little Egret (*Egretta garzetta*, waterbirds). There were nine common species, of which terrestrial birds outnumbered waterbirds. Among these, five common species were terrestrial birds – Japanese White-eye (*Zosterops japonicus*), Crested Myna (*Acridotheres cristatellus*), Common Tailorbird (*Orthotomus sutorius*), Eurasian Tree Sparrow (*Passer montanus*) and Chinese Hwamei (*Garrulax canorus*); and four were waterbirds: Kentish Plover (*Charadrius alexandrinus*), Black-crowned Night Heron (*Nycticorax nycticorax*), Grey Heron (*Ardea cinerea*), and Chinese Pond Heron (*Ardeola bacchus*). Square-tailed drongo-cuckoo (*Surniculus lugubris*) and Tufted Duck (*Aythya fuligula*) were newly recorded in 2018. Since 2006, over 263 species of birds from 16 orders and 60 families have been recorded.

There are abundant fish stocks in Macao, which can be categorised into saltwater fish, brackish fish and freshwater fish. Saltwater fish and brackish water fish mainly refer to the fish off the coast of Macao. There are approximately 200 species of these fish. Freshwater fish most need protection in the natural environment. Although the habitats of freshwater fish and amphibians are similar to each other, the former have a narrower sphere of activities. Whenever the environment is destroyed or altered by human activities, they are often affected most directly.

There are over 600 species of insects, which are widely distributed in Macao, including 119 butterfly species.

## Laws Governing Nature Conservation

Macao began to enact laws and regulations on nature conservation – including the establishment of nature reserves and the protection of flora and fauna of special interest – more than 30 years ago. New by-laws were promulgated in 2004 to replace older ones. They are as follows:

1. Decree-Law No. 33/81/M, gazetted on 19 September 1981; Decree-Law No. 30/84/M, amended on 28 April 1984; and Decree-Law No. 3/99/M, revised on 25 January 1999, which designated a 196,225-square-metre area of Seac Pai Van Country Park as a conservation area of outstanding educational, ecological, scenic and scientific value;
2. Law No. 11/2013, approved by the Legislative Assembly on 13 August 2013, and By-law No. 31/2018 and enacted on 4 May 2018, which designated part of Coloane island with an altitude of 80 metres or above as a buffer zone;
3. The Environmental Law, approved by the Legislative Assembly on 31 January 1991 and gazetted by Law No. 2/91/M on 11 March 1991, which set out general guidelines and basic principles for the formulation of environmental policies;
4. General Regulations Governing Public Places (By-law No. 28/2004) enacted on 28 July 2004, which established general principles for behaviour to be observed when using and enjoying public places; and
5. By-law No. 40/2004 on Sanitary and Phytosanitary Control enacted on 14 December 2004, which regulates the sanitary and phytosanitary control of merchandise, and implements Chief Executive Order No. 245/2014 on the List of Plant Pests for Regulation as Quarantine Pest Organisms of the Macao SAR.
6. The Animal Protection Law (Law No. 4/2016) came into effect on 1 September 2016, with regulations on keeping, managing and selling animals, and the use of animals in public exhibitions and scientific applications. In addition, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Biological Diversity, and the International Plant Protection Convention have been made applicable to Macao, thus ensuring that Macao's nature conservation policies conform to international practices.

## Nature Reserve

The Taipa-Coloane Wetland Reserve managed by the Environmental Protection Bureau is situated adjacent to the Lotus Flower Bridge in Taipa and Coloane. It has a total area of 55 hectares, including a 40-hectare bird foraging area that is regarded as zone two of the reserve, on the west coast of reclaimed area between Taipa and Coloane. Next to this zone is a 15-hectare bird habitat, regarded as zone one of the reserve, which provides different bird species (including the rare Black-faced Spoonbill) with suitable habitats.

As at the end of December 2018, the Cotai Nature Reserve's known biodiversity included 217 species of planktonic algae, 381 species land plants (embryophytes), 134 plankton species, 131 zoobenthos species, 484 species of insects, 70 species of fish, five species of amphibians, 20 species of reptiles and 10 species mammals. This diversity helped attract 177 species of birds to the nature reserve, including the Black-faced Spoonbill (*Platalea minor*).

To enrich education on ecology, apart from Cotai Nature Reserves Open Day and the "Nature School" family workshop, bird watching in nature reserves was organised for the first time in 2018, to raise awareness of environment protection.

## Country Parks

There are four country parks in Macao: Seac Pai Van Country Park, Taipa Grande Nature Park, Hac Sa Reservoir Country Park, and Ka Ho Reservoir Country Park.

### Seac Pai Van Country Park

Adjacent to Seac Pai Van Road in western Alto de Coloane, Seac Pai Van Country Park covers an area of about 198,000 square metres, and provides a wide range of facilities. Its animal facilities comprise the Giant Panda Pavilion, a zoo, and an aviary. Its exhibitions facilities feature the Giant Panda Information Centre and the Museum of Nature and Agriculture. Other leisure facilities include a children's playground, a large picnic area and a snack bar.

### Giant Panda Pavilion

Set against a hill side in Seac Pai Van Park of Coloane, with a fan-shaped layout and an area of about 3,000 square metres, Macao Giant Panda Pavilion is designed to combine the terrain's natural undulations with the architectural characteristics. The pavilion comprises two 330-square metre indoor activity quarters and a 600-square metre outdoor yard. The appearance of the Macao Giant Panda Pavilion is designed to mimic nature, and it features green elements with leisure facilities such as pools and wooden climbing frames for the pandas.

### Taipa Grande Nature Park

Taipa Grande Nature Park is on the east of Taipa island, and covers a wooded and hilly area of 13,000 square metres between Ponta da Cabrita Road, Governador Nobre de Carvalho Avenue and Padre Estevaso Eusebio Situ Road. The park houses a native fish breeding zone, 56 sculptures representing the 56 Chinese ethnicities, Taipa Grande exhibition hall, barbecue area, grass skiing slope, children's playground and a

memorial pavilion for Mr. Henry Fok. It is a multifunctional park for relaxation, exercise, environmental protection, education and retreat. It is also an ideal destination for Macao residents to enjoy forest scenery to the full, embrace nature and enrich their leisure time.

### Chinese Ethnic Sculpture Park

Located within Taipa Grande Nature Park, the Chinese Ethnic Sculpture Park is Macao's first ethnic-themed sculpture park. It is divided into a sculpture gallery and an exhibition hall.

### Hac Sa Reservoir Country Park

Hac Sa Reservoir Country Park is situated in a hilly forest area on the southeastern slopes of the central mountain of Coloane. The park occupies 371,000 square metres between the entrance of the Westin Resort Macau on Hac Sa Road to the east, and Chu Ku Tong pond, in front of Man Hong Un, to the south. The Hac Sa aquatic plant zone and aquatic plant watching zone are for nature protection and education.

### Ka Ho Reservoir Country Park

Ka Ho Reservoir Country Park is situated on the northeast of Coloane island. The park faces Ka Ho Village to the east, separated by Barragem de Ka Ho Road. Seac Pai Van Reservoir lies to its west; and the golf course and Alto de Coloane Road lie to its south. It is bordered by a road that leads to the youth challenge centre in the north; and it stretches all the way down to a wooded and hilly area by the shoreline. Ka Ho Reservoir Country Park has an area of 81.8 hectares.

With Ka Ho Reservoir as its central point, the park boasts various facilities, including the Ka Ho Reservoir Trail, Northeast Trail, Dam Mural, Waiting Square, and Little Spring; as well as barbecue, and picnic areas; the Blossom Bridge; diversity games zone; Ka Ho Reservoir Outdoor Experimental Camp; and the Freshwater-Wetland Ecological Zone. With its educational and recreational features, Ka Ho Reservoir Country Park is an ideal place to spend leisure time.

## Population

Macao's resident population was estimated to be 667,400 as at the end of 2018, representing an increase of 14,300 or 2.2 percent over the previous year. On the same date, an estimated 46.9 percent of Macao's population were males, and 53.1 percent were females.

Natural factors are among the reasons for the increase in population. In 2018, there were 5,925 newborn babies, 2.2 percent fewer than in 2017, and 2,069 deaths, representing a decrease of 6.6 percent. Hence, the natural population growth rate was 0.59 percent.

On top of this increase, there was a change in immigration, another factor influencing population. The net number of immigrants was 10,500 in 2018, 6,700 more than in the previous year due to an increase in foreign employees residing in Macao.

Most residents lived in Our Lady of Fatima Parish, with 254,000 residents, comprising 38.1 percent of the total population.

## Birth and Death Rates

In 2018, the birth rate and death rate were 0.9 percent and 0.31 percent, respectively.

## Population Ageing

Macao's population is ageing because of the increasing life expectancy. Senior citizens (aged 65 or above) made up 11.1 percent of the population, 0.6 percent more than in 2017; the number of other adults (aged 15-64) dropped by one percentage point, representing 75.7 percent of the population. The ageing index increased by 1.1 percentage points to 84.1 percent of the population, over the previous year, marking the 22nd consecutive year this index has increased.

The ageing in the population of Macao people is more significant, with 74,100 senior citizens (aged 65 or above), 7.5 percent more than in the previous year; the number of other adults (aged 15-64) dropped by 0.5 percent to 386,000. The elderly dependency ratio of the population of Macao people was 19.2 percent, which means there was one senior citizen for every five adults.

## Identification Bureau

Under the Basic Law of the Macao SAR, the Macao Special Administrative Region Government is authorised by the central government to issue MSAR Passports to Chinese citizens who hold MSAR Permanent Resident ID cards, and to issue other types of MSAR travel permits to other legal residents of Macao. MSAR Passports and travel permits are valid for worldwide travel, and entitle their holders to return to Macao.

The Identification Bureau is under the administration of the Secretariat for Administration and Justice, and is responsible for the overall planning and work relating to the civil and criminal identification of Macao residents. It issues ID cards and certificates of criminal record, certificates to substantiate the facts stated in official

record, MSAR Passports, and other travel permits to Macao residents. It also responsible for handling nationality applications from MSAR residents, receiving and handling applications for Certificate of Entitlement to Right of Abode and issuing the related certificates, arranging the registration of associations and syndicates qualified as juridical persons and issuing the related certificates, as well as other duties as vested by law.

## Personal Identity Cards

Only Chinese citizens who are permanent residents in Macao with a Macao Resident ID card are eligible to apply for an MSAR Passport. A Chinese citizen who is a Macao Resident ID cardholder, but not a permanent resident of Macao and not eligible for other travel permits, may apply for an MSAR travel permit.

By 31 December 2018, the Identification Bureau had issued 686,787 MSAR Passports and 49,493 travel permits.

Under the Nationality Law of the People's Republic of China and the Interpretation by the Standing Committee of the National People's Congress on Several Questions Relating to the Application of the Nationality Law of the People's Republic of China in the Macao Special Administrative Region, any permanent resident of Macao with Chinese nationality and a Portuguese travel document may travel to other countries or regions with the Portuguese travel document as before. Therefore, such people may hold both a Macao SAR Passport and a Portuguese travel document at the same time.

The Identification Bureau is responsible for issuing Visit Permits for Residents of the Macao SAR to the Hong Kong SAR (also known as "Visit Permits to the HKSAR"). Residents of the MSAR who are either Chinese or Portuguese citizens and who hold a Macao Resident ID card or an MSAR Resident ID card may apply for Visit Permits to the HKSAR. The bureau had issued 441,470 such permits as at 31 December 2018.

The Identification Bureau is also responsible for issuing Macao SAR Resident ID cards. As at 31 December 2018, there were 719,634 Macao SAR Resident ID card cardholders. Between 1 January and 31 December 2018, 13,217 residents received Macao SAR Resident ID cards for the first time.

## Nationality

Under Law No. 7/1999, the Identification Bureau is responsible for handling nationality applications from MSAR residents, including applications by foreign nationals or stateless persons for naturalisation; applications by Chinese citizens to renounce Chinese nationality; applications by foreigners who previously had Chinese nationality to restore Chinese nationality; applications by MSAR residents of both Chinese and Portuguese descent to choose either Chinese or Portuguese nationality; and applications

by original Macao residents who are Chinese citizens with other nationalities to adopt Chinese nationality.

Between 20 December 1999 and 31 December 2018, 1,137 applications for naturalisation were approved; 543 people restored their Chinese nationality; 90 renounced their Chinese nationality; 3,054 successfully applied to adopt Chinese nationality; 66 opted for Portuguese nationality; and there were five applications for change of nationality.

### **Certificate of Entitlement to Right of Abode**

A certificate of entitlement to right of abode confirms the status of a permanent resident of the MSAR. Any person who claims to have right of abode in the MSAR but does not hold a valid Macao Resident ID card or MSAR Resident ID card and who does not live in any other region of the People's Republic of China (except the Hong Kong SAR and Taiwan) must apply for a certificate of entitlement to right of abode.

Such people include Chinese citizens who have ordinarily resided in Macao for seven consecutive years before or after the establishment of the Macao SAR; children of Chinese nationality born outside Macao whose parents are Chinese nationals and permanent residents of Macao; people of both Chinese and Portuguese descent who have ordinarily resided in Macao for seven consecutive years before or after the establishment of the MSAR; and children of Chinese nationality or children born outside Macao who have not selected a nationality but intend to reside in Macao permanently and whose parents are permanent Macao residents of either Chinese citizenship or Portuguese descent. The certificate of entitlement to right of abode indicates its date of effectiveness, prior to which holders of the certificate have no right to enter or reside in Macao.

Between 20 December 1999 and 31 December 2018, the Identification Bureau issued 80,478 certificates of entitlement to right of abode.

### **Certificate of Criminal Record**

In August 1996, the Identification Bureau started to issue certificates of criminal record and certificates of special record for minors. The former is the sole and sufficient document to prove whether an applicant has any criminal record; while the latter is applicable to those under 16.

Between 1 January and 31 December 2018, the bureau issued a total of 99,191 certificates of criminal record. Of these, 78,560 were public applications, and 20,631 were agency applications. Among the 93 certificates of special record for minors that were issued, 82 were to applicants through agency, and 11 to public bodies.

## Immigration Controls

According to the Basic Law of the Macao SAR, the Government may impose restrictions on people from other countries or regions entering, staying in, and leaving Macao. The Immigration Department of the Public Security Police is responsible for entry and exit in Macao.

The MSAR Immigrant Department records the entry and exit of non-residents, as well as their passport, visa, or other relevant documents for reference. The period of stay is granted according to stipulations in By-law No. 5/2003.

By 31 December 2018, citizens of 79 countries enjoyed visa-free access to Macao. Valid passport holders of these countries and regions may enter and stay in Macao for 14 to 90 days, while those from the United Kingdom may stay for up to six months. PRC passport or travel permit holders who have a valid air ticket and visa issued by the country or region of destination may stay for a maximum of seven days in Macao.

## Legal Immigration

A decrease in mainland China immigrants has been recorded for three consecutive years. During 2018, the number of mainland China immigrants dropped by 674, totalling 3,532. Of these, immigrants from Guangdong Province decreased by 604 to 2,262, with females comprising 65.1 percent of the total.

## Overstaying and Illegal Entry

In 2018, 27,609 overstayers were repatriated. They included 25,876 mainland Chinese, 80 Taiwan (China) residents, 72 Hong Kong residents, 1,581 foreign nationals, and 21,777 voluntarily repatriated mainland Chinese.

## Civil Registration

The Civil Registry is responsible for implementing regulations relating to the civil registration of births, parentage, adoption and child custody, marriage agreements, deaths, legal certification of the deaths of missing persons, and issuing relevant certified documents.

## Birth Registration

The Birth Registry is responsible for the registration of births in Macao, as well as the re-registration of births of people aged 14 or over. The Civil Registry should be

verbally notified of any birth in Macao by the parents or guardians within 30 days. The registry registered 5,983 births during 2018.

### **Marriage Registration**

The Civil Registry is responsible for handling applications for marriages, approving marriage registrations, hosting ceremonies for the signing of marriage certificates and registering marriages. A total of 3,842 marriages were registered during 2018.

### **Death Registration**

Family dependents or other relatives of a deceased person may register his or her death with the Civil Registry or its staff assigned to the registry's branches at Conde S. Januario Hospital and Kiang Wu Hospital. There were 2,187 death registrations during 2018.

### **Divorce by Mutual Consent**

The Civil Registry has the authority to process divorce by mutual consent. Applicants who have been married for over one year, have no children aged under 18, and have reached agreement on maintenance payments and ownership of their residences may submit applications to the Civil Registry. There were 675 divorce applications during 2018.



# LONG CHAO KOK COASTAL TRAIL

The Long Chao Kok Coastal Trail in Hac Sa is a mostly level trail, running from Rua de Hac Sá Long Chao Kok to the Cheok Van villa cluster. The route passes jagged stones, creating beautiful scenery with high biodiversity.

To bring local residents and tourists into close contact with Long Chao Kok, the Government started conducting research on local natural landscapes in 2000, including the topography and habitats, for planning construction of the trail. This 1,200 metre-long seaside trail of medium difficulty was completed in 2003.

Walking along the coast, where sea breezes whisper with seabirds soaring high, is the best leisure activity for families and friends to get close to nature in Macao.



